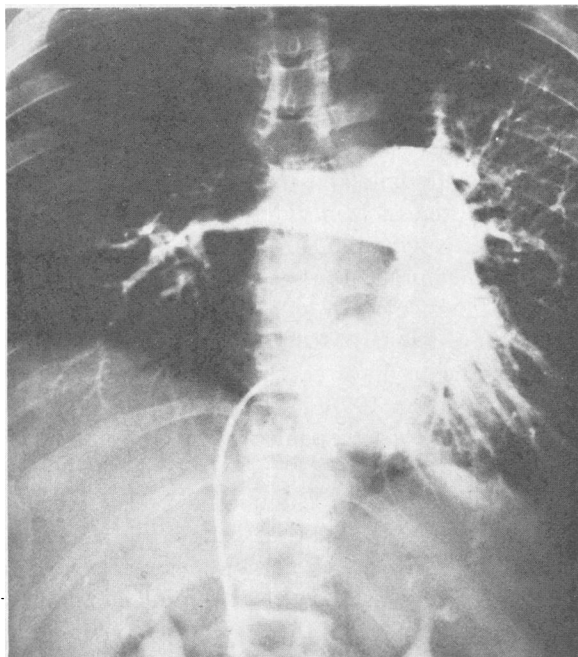


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**Figure 1.**—Pulmonary angiogram showing filling defect in right main pulmonary artery and absence of flow to the right upper lobe.

cal improvement occurred in two days with reduction of the fever and chest pain. Radionuclide venograms (using  $^{99m}\text{Tc}$ -MAA) of the lower extremities done a week after admission were normal. The skin and mucous membrane lesions gradually resolved and the patient was discharged on a regimen of sodium warfarin (Coumadin®) and prednisone after two weeks in hospital.

### Discussion

The precise pathogenesis of erythema multiforme has not been firmly established. Its occurrence after exposure to a variety of unrelated agents may suggest an immune mechanism and histopathologic findings of allergic vasculitis would tend to support this.<sup>9</sup> Vasculitis may account for some of the reported manifestations of erythema multiforme including glomerulonephritis and microangiopathic hemolytic anemia.<sup>10,11</sup> The pulmonary vascular occlusion in our patient may likewise be a manifestation of the vasculitis of erythema multiforme. He had one documented episode of pulmonary thromboembolism that occurred coincidentally with an exacerbation of erythema multiforme. A previous bout of acute erythema multiforme in September 1973 was also accompanied by features suggestive of pulmonary thromboembolism (pleuritic chest pain, dyspnea

and serosanguinous pleural effusion). To our knowledge, pulmonary thromboembolism has not been reported in erythema multiforme. It is possible that some of the previously reported cases of "pneumonitis" in erythema multiforme are secondary to pulmonary thromboembolic disease.

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Refer to: Seltzer RA: Pneumoperitoneum following intermittent positive pressure breathing. *West J Med* 126:506-509, Jun 1977

## Pneumoperitoneum Following Intermittent Positive Pressure Breathing

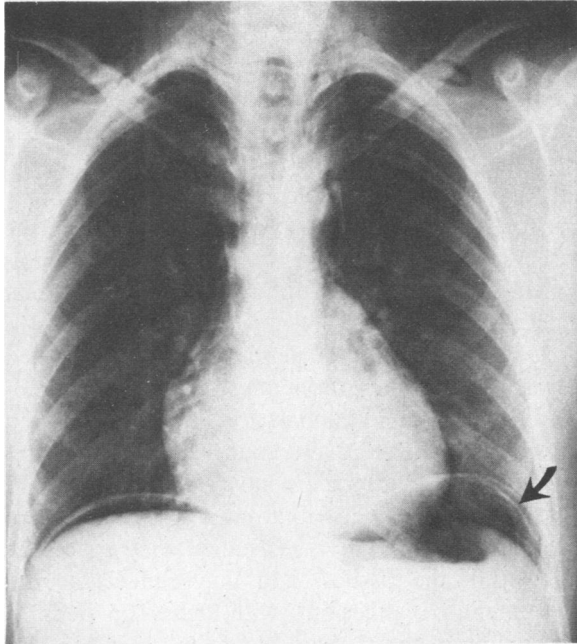
RONALD A. SELTZER, MD  
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THERE ARE SEVERAL reports of pneumoperitoneum secondary to progressive pneumomediastinum in neonates with respiratory distress syndrome or chronic pulmonary disease.<sup>1-4</sup> Recently, this phenomenon has been described in three adults receiving mechanical ventilation, in two of whom exploratory laparotomy was done for suspected perforated viscus.<sup>5</sup> The following report is the

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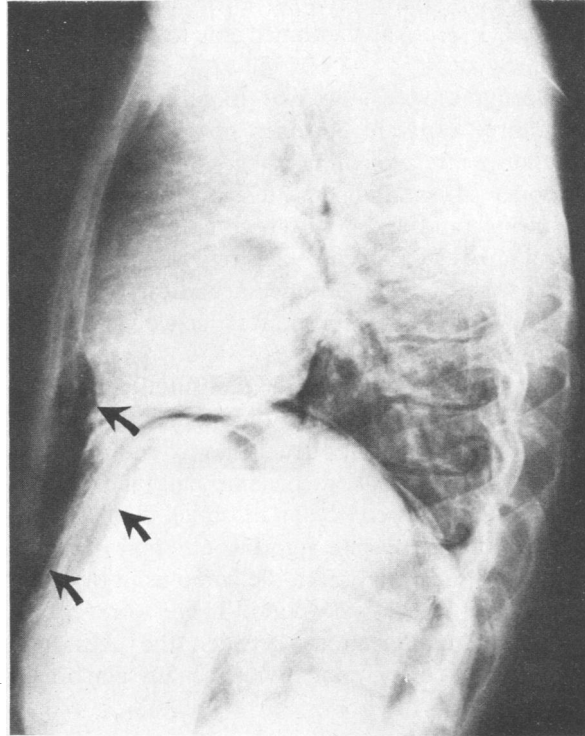
**Figure 1.**—Posteroanterior view of the chest on admission. Note subcutaneous and mediastinal emphysema and pneumoperitoneum. A small streak of air is seen in the retroperitoneal space along the inferior aspect of the left hemidiaphragm (arrow).

case of a young man with asthma in whom pneumomediastinum and pneumoperitoneum developed while the patient was using an intermittent positive pressure breathing (IPPB) machine at home.

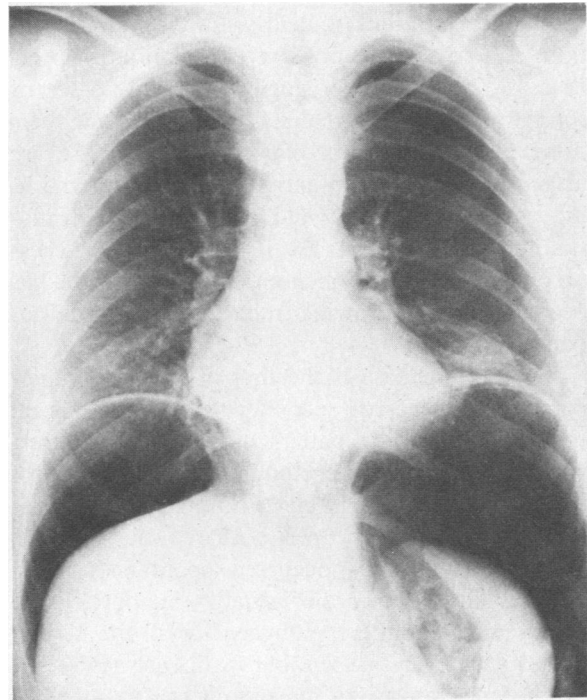
### Report of a Case

In a 22-year-old white man, low anterior chest pain occurred at home while he was using isoproterenol in an IPPB machine with the pressure limit at 20 cm of water. The patient had had chronic asthma since childhood and was maintained on a regimen of prednisone and aminophyllin taken each day. One month earlier, a small left pneumothorax had developed while the patient was using the same IPPB machine. It subsided with conservative therapy. On physical examination at the current admission, the abdomen was noted to be soft. Cervical subcutaneous emphysema was present.

A radiograph of the chest showed subcutaneous emphysema, pneumomediastinum, pneumoperitoneum and air in the retroperitoneal space (Figure 1). Results on a gastrografin upper gastrointestinal series were normal. The patient was treated conservatively with spontaneous reduction of the pneumomediastinum, subcutaneous



**Figure 2.**—Lateral view of chest during fourth episode. Note the extensive air descending from the anterior mediastinum into the anterior retroperitoneal space (arrows).



**Figure 3.**—Posteroanterior view of the chest during final admission. A small left pneumothorax has appeared and there is a large pneumoperitoneum. Little retroperitoneal air is seen.

emphysema and pneumoperitoneum over the next four days. He was cautioned not to use the IPPB machine again.

During the ensuing two months, the patient had three separate episodes of small left pneumothorax after coughing or sneezing and a fourth episode of spontaneous tension pneumothorax requiring tube drainage. These episodes were accompanied by varying degrees of pneumomediastinum, pneumoperitoneum and air in the abdominal wall, retroperitoneal space and neck (Figure 2 and 3).

Finally, two months after the initial illness and while in hospital because of another episode of pneumomediastinum, pneumothorax and pneumoperitoneum, the patient became pale and breathless, and appeared to be in shock. He died in fifteen minutes despite vigorous attempts at resuscitation. On autopsy, a saddle embolus in the main pulmonary artery was found. There were no abnormal communications between the chest and abdominal cavity, nor evidence of perforated viscus.

### Discussion

Almost all of the previously reported cases of pneumoperitoneum following pneumomediastinum have occurred in patients receiving continuous mechanical ventilation, nearly always with intubation, and often with positive end-expiratory pressure.<sup>1-8</sup> There is a single reported case of spontaneous pneumomediastinum and pneumoperitoneum in an 18-year-old man during a severe attack of asthma<sup>9</sup> and another following a crushing chest injury.<sup>8</sup> It would seem that hyperinflation or high alveolar pressures, or both, are necessary to produce this phenomenon, although it has occurred rarely following tracheostomy<sup>10</sup> and after dental extraction.<sup>11</sup>

The current case is the first in which pneumoperitoneum occurred secondary to the use of oral IPPB. Although the patient stated that the pressure was set at the customary level (20 cm of water), there is no way of knowing if he was using the machine properly. Moreover, since the subsequent episodes occurred spontaneously, it is uncertain whether the initial event opened the necessary anatomical pathways or if the tissues were particularly susceptible to dissection by air.

The mechanism of development of pneumothorax, pneumomediastinum and pneumoperitoneum has been established experimentally and shown to occur in many different clinical settings.<sup>12</sup>

Air under increased pressure within the alveoli ruptures into the interstitial space and dissects along the pulmonary vessels to the mediastinum. Continued leakage of air may produce subcutaneous emphysema as the air dissects along the fascial planes to the neck, pneumothorax if the air ruptures into the pleural space, or pneumoperitoneum as the air dissects inferiorly along the visceral and the vascular planes to the retroperitoneal space and then ruptures into the peritoneal cavity.

It is interesting that nearly all of the reported cases of pneumoperitoneum following pneumomediastinum of pulmonary origin have occurred in infants or in relatively young adults (in all reported cases the patients have been less than 49 years old). This distribution is probably a reflection of the relative resistance to the flow of air within the tissues, and may reflect the development of adhesions with aging or perhaps weakening of the parietal pleura in older persons. In the neonates in whom pneumoperitoneum developed, it is postulated that massive, tension pneumomediastinum allows the air to dissect posteriorly to the natural diaphragmatic openings and thence to the abdomen.<sup>4</sup> In the case reported here, the radiographs (Figure 2) suggest that the air dissected directly from the anterior mediastinum into the anterior chest wall and then into the retroperitoneal space of the anterior abdominal wall and finally into the peritoneal cavity, a pathway which has been described before.<sup>10</sup> The crescent shaped streak of the retroperitoneal subdiaphragmatic air which may be thickest at a point medial or lateral to the highest point of the diaphragm can be distinguished from intraperitoneal air which rises freely to the highest point of the diaphragm (Figure 1) and may, if fluid is present, have a flat lower margin.<sup>10</sup>

Other causes of spontaneous pneumoperitoneum unrelated to ruptured viscus or laparotomy are known. They include entry of air through the female reproductive tract during sexual activity, douching, pelvic examination and postpartum exercises, as well as pneumatosis cystoides intestinalis.<sup>13</sup> It is important to be aware of these possibilities in order to avoid unnecessary surgical operation in a search for a ruptured viscus. Such operations had been done in three of the reported cases that occurred following pneumomediastinum in adults.<sup>5,8</sup> Unnecessary laparotomy has also been done in an infant.<sup>3</sup> In the current case and in three others, gastrografin contrast studies were

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used to search for a ruptured viscus.<sup>1,2,8</sup> Abdominal paracentesis has also been used to exclude peritonitis.<sup>2,4,8</sup>

### Summary

A case is presented of pneumoperitoneum secondary to the use of an intermittent positive pressure breathing machine. Although uncommon, this potential source of pneumoperitoneum should be considered and, if indicated, additional diagnostic studies employed in order to avoid laparotomy to search for a ruptured viscus.

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## Handling a Parent with Asthma

How can negative psychological effects of an asthmatic parent on a child with asthma be reduced?

The first thing I think I would do is say to the parent, "You know, it's just going to be very difficult for you to follow my advice, because you've got another set of advice in your head from when you were little, and I really would like to help you separate those things out." So you are as clear as possible about the fact that there's a problem. You've not judgmental about it; you're just describing that this is going to be difficult for them. Then you say, "OK, it would help me to learn as much about you and *your* asthma as possible." And then get them to tell you everything terrible they can think of about their own asthma and about their relationships with their parents, so that you've got a backlog of information to work with. Then, when you're advising the parent—let's say, for example, it is a mother who doesn't want to let her boy go out and play because every time he goes out and plays he comes back wheezing a little bit—you can say to her, "How was it with you when you were little?" And then say, "... it's really OK for him to go out and play . . . he has to learn his own limits. If you set limits, you're depriving him of learning . . ." You simply try to get as specific as possible about your advice and the child's needs, and accept the parents' problems and help him or her to work with them. Most parents really appreciate that . . . they really don't mind that kind of constructive hassling.

—WILLIAM M. BOLMAN, MD, *Honolulu, Hawaii*  
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